

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claims 1-32 (Canceled)

33. (Currently Amended) A method of operating an ionized physical vapor deposition system comprising:

positioning a ~~patterned~~ substrate on a cooled wafer table in a processing chamber, the substrate having a dielectric layer thereon, the dielectric layer having a field area and a plurality of features formed therein and each of the plurality of features including a field area, a sidewall, [[and]] a bottom surface, and an opening on a wafer table within a processing chamber, wherein the wafer table is cooled;

creating a high-density plasma in the processing chamber, wherein the high-density plasma comprises metal ions of ruthenium in a Low Net Deposition (LND) process gas target material and a large number of ~~process~~ inert gas ions;

exposing the ~~patterned~~ substrate to the high-density plasma;

performing a ~~Low Net Deposition (LND)~~ an LND process step wherein the LND process gas, a target power, or a substrate bias power, or a combination thereof, is adjusted to establish an LND deposition rate;

the performing of the LND process step including depositing a ~~ruthenium~~ barrier layer onto the field area at a deposition rate of greater than zero and not more than 30 nanometers per minute (nm/min) while depositing or etching ~~ruthenium~~ the deposited barrier layer, or a combination thereof, on the sidewall or the bottom surface, or a combination thereof, by simultaneously directing the metal ions of ruthenium the target material LND process gas and the inert gas ions of inert processing gas onto the substrate and thereby depositing ~~ruthenium~~ the barrier layer onto the field area of the ~~substrate~~ dielectric layer while etching the deposited

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~~ruthenium~~ barrier layer from the field area and thereby producing substantially no overhanging material at the feature openings;

changing the process from an LND process step to a No Net Deposition (NND) process step, thereby changing the deposition rate from an LND deposition rate to an NND deposition rate; and

processing the patterned substrate using an NND process gas during the NND process step by depositing ~~ruthenium~~ the barrier layer on the sidewall while depositing or etching ~~ruthenium~~ the barrier layer, or a combination thereof, on the field area or the bottom surface, or a combination thereof at a rate ranging from about -10 nm/min to about 10 nm/min, and wherein a chamber pressure, chamber temperature, substrate temperature, an NND process gas chemistry, an NND process gas flow rate, an ICP power, a substrate position, a target power, or a substrate bias power, or a combination thereof, is adjusted to change the process from the LND process to the NND process;

wherein the NND process step is used to deposit the ~~ruthenium~~ barrier layer onto the barrier layer deposited by the LND process step.

Claims 34-93 (Canceled)

94. (Currently Amended) A method of processing a semiconductor substrate[[s]] by depositing material into a plurality of features formed in a dielectric layer on [[of]] the ~~patterned~~ substrate, the dielectric layer having a field area and each of the plurality of features having a sidewall, a bottom surface, and an opening, wherein the plurality of features of the dielectric layer have a ruthenium barrier layer deposited thereon, and wherein ~~while producing~~ substantially no overhanging material is produced at the opening of each of the plurality of features, the method comprising:

positioning ~~a patterned~~ the substrate on a wafer table within a processing chamber of an ionized physical vapor deposition (iPVD) system, wherein the wafer table is cooled;

creating, in the processing chamber, a high-density plasma of process gas ions that includes vaporized metal coating material having a high fraction of positive ions;

exposing the ~~patterned~~ substrate to the high-density plasma that includes the vaporized metal coating material and gas ions and performing therewith on the substrate an ~~ionized physical vapor deposition~~ iPVD process while controlling parameters of the iPVD system to simultaneously coat and etch the ruthenium barrier layer ~~substrate~~ so as to thereby establish a net deposition rate ~~of not more than approximately 30 nanometers per minute~~ ranging from about -10 nm/min to about 10 nm/min onto the field area ~~of the substrate~~ while the vaporized metal coating material is deposited and etched on the sidewall or bottom surface, or a combination thereof;

the performing of the ~~ionized physical vapor deposition~~ iPVD process includes the depositing of a seed layer onto the ruthenium barrier layer ~~sidewalls of vias or trenches of the features of the dielectric layer on the substrate, wherein the seed layer comprises ruthenium.~~

Claims 95-111 (Cancelled)

112. (New) The method according to claim 33, wherein the ionized physical vapor deposition system further includes a target positioned within the processing chamber and coupled to a wall thereof, a permanent magnet pack coupled to the target, and a DC power source coupled to the target.

113. (New) The method according to claim 112, wherein the target is at least partially constructed from ruthenium.

114. (New) The method according to claim 33, wherein the ionized physical vapor deposition system further includes an antenna positioned outside the processing chamber, a dielectric window coupled to a wall of the processing chamber near the antenna, a louvered deposition

baffle coupled to the dielectric window, and an inductively coupled plasma source coupled to the antenna.

115. (New) The method according to claim 33, wherein the ionized physical vapor deposition system further includes a gas supply system coupled to the processing chamber, wherein the gas supply system is configured to supply an inert gas comprised of at least one of argon (Ar), helium (He), krypton (Kr), radon (Rn), or xenon (Xe) to the processing chamber.

116. (New) The method of operating a deposition system as claimed in claim 115, wherein the method further comprises:

flowing a first process gas into the processing chamber during at least a portion of the LND processing time, wherein the first process gas comprises an inert gas, a nitrogen-containing gas, an oxygen-containing gas, or a metal-containing gas, or a combination thereof.

117. (New) The method of operating a deposition system as claimed in claim 33, wherein the metal-containing gas comprises tungsten (W), copper (Cu), tantalum (Ta), titanium (Ti), ruthenium (Ru), iridium (Ir), aluminum (Al), silver (Ag), or lead (Pt), or a combination thereof.

118. (New) The method of processing semiconductor substrates according to claim 94, wherein the seed layer comprises copper (Cu) or ruthenium (Ru).

119. (New) The method of processing semiconductor substrates according to claim 94, wherein the iPVD system further includes an antenna positioned outside the processing chamber, a dielectric window coupled to a wall of the processing chamber near the antenna, a louvered deposition baffle coupled to the dielectric window, and an inductively coupled plasma source coupled to the antenna.

120. (New) The method of processing semiconductor substrates according to claim 94, wherein the iPVD system further includes a target positioned within the processing chamber and coupled to a wall thereof, a permanent magnet pack coupled to the target, and a DC power source coupled to the target.

121. (New) The method of processing semiconductor substrates according to claim 94, wherein the iPVD system further includes a gas supply system coupled to the processing chamber, wherein the gas supply system is configured to supply an inert gas comprised of at least one of argon (Ar), helium (He), krypton (Kr), radon (Rn), or xenon (Xe) to the processing chamber.